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Integrating a Quasi-2D hydraulic model, remote sensing and VGI data into a data assimilation framework for real time flood forecasting and mapping

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The intensification of flood damages and fatalities is causing an increasing need of adopting Early Warning Systems (EWS) that are able to predict flood dynamics and impacts from the local to the global scale. While flood hazard zoning remains the main source of knowledge for risk management, EWS are the main support for decision makers to take effective, timely and responsible decisions to reduce fatalities and economic losses, especially in urban areas. EWS are generally based on the implementation of hydrologic and hydraulic models that are usually affected by uncertainties that can be extremely significant in data scarce regions, and this source of uncertainty propagates directly to the flood risk decision and management.

This work presents the development of a Data Assimilation (DA) framework for flood forecasting characterized by the integration of a Quasi- 2D hydraulic model (FLO-2D) for flood wave routing with geospatial models and data. The input hydrologic forcing is defined by both flow gages and a simplified GIS-based geomorphic rainfall-runoff scheme tailored for small ungauged basins. The selected DA method is the Ensemble Kalman Filter (EnKF). Boundary conditions of the hydraulic model include hot starts for assimilating available information within the DA for improved accuracy of the flood wave routing. Assimilated information includes: local channel water level observations from the monitoring network (stage gages); observed floodplain water depths gathered from web data mining (i.e. Volunteered Geographic Information or VGI); inundation extents extracted from remotely sensed (EO) images (e.g. satellites, drones).

Results confirm the efficiency of the DA framework in improving the performances of the flood forecasting model in simulating water levels, while reducing the modelling uncertainties. Moreover, the spatially distributed results produced by the 2D inundation model allowed to evaluate how the water level correction influences the flood extension. Additionally, the presented modelling approach efficiently supports the gathering and integration of novel observation data derived from EO and crowdsourced data overcoming the limitations and inaccuracies of traditional sensors.